DESCRIPTION

TITLE OF THE INVENTION

METHOD AND DEVICE FOR BENDING BLADE MEMBER

TECHNICAL FIELD

The present invention relates to a method and device for bending a blade member in a width direction by warping the blade member in the width direction.

BACKGROUND ART

Figs. 14, 15 show a case for forming a notch or a perforation in a workpiece W such as sheet paper using a rotary die 100 provided with a blade member 1 from viewpoint of principle. The rotary die 100 is used in combination with an anvil 200 which is a reception side roller. The blade member 1 mounted on the rotary die 100 is curved in parallel to the outer peripheral face of the rotary die 100 such that a blade point 12 equipped on an end edge in the width direction is protruded from the outer peripheral face of the rotary die 100. Then, the workpiece W is fed into between the rotary die 100 and the anvil 200, rotated in the direction of an arrow F and as a result, a notch or a perforation meeting the configuration of the blade point 12 of the blade member 1 is formed in the workpiece W. In the meantime, as the anvil 200, iron-made one whose surface is hard and rubber-made one whose surface is soft are used appropriately depending on the purpose.

As for the blade member 1 to be mounted on the rotary die 100, as

shown in Fig. 16, in some case, a straight belt-like blade member 1 is purchased and it is bent into a circular shape in the width direction as shown in Fig. 17. In other case, a processed product which is already bent into the circular shape in the width direction through its entire length is purchased as shown in Fig. 19. In the latter case, a product whose blade point 12 is specified to various curvatures can be purchase. For the former case, there is such an advantage that the curvature of a blade point 12 can be specified at a desired value by a bending process. Then, if a straight belt-like blade member 1 as shown in the former case is purchased and bent into the circular shape for use, a method for feeding the belt-like blade member 1 in conditions in which it is nipped with three rollers 301, 302, 303 as shown in Fig. 18 is adopted. In the meantime, according to this method, as shown in Fig. 18, each of the rollers 302, 303 on the side for supporting the blade point 12 includes a groove 304 for supporting the blade point 12 in non-contact condition. The bending method indicated in Figs. 17, 18 has been described in Japanese Patent Publication No. 46-18352.

However, if the product whose entire length portion is already processed to a circular shape as shown in Fig. 19 is purchased, there is such a problem that any product whose curvature in blade points 12 is appropriate often cannot be found out even if there are available various products whose curvatures are diversified. If a straight belt-like blade member 1 is purchased like the former case and bent into the circular shape, a straight unprocessed portion A is left unavoidably on each of both end portions of the bent blade member shown in Fig. 17 due to the structural reason of the bending device shown in the same figure and a process for cutting out that

unprocessed portion A to leave only an effective portion produced by bending is unavoidable and therefore, there is such a problem that the yield rate of material drops thereby cost being increased.

DISCLOSURE OF THE INVENTION

The present invention has been achieved in view of the above-described problems and an object of the invention is to provide a method and device for bending a blade member capable of bending the entire length portion of a straight belt-like blade member and deforming into a curved shape in which the blade point is expanded.

Another object of the present invention is to provide a method and device for bending a blade member capable of bending the blade member without any experienced skill.

According to the present invention, there is provided a method for bending a blade member in the width direction by deforming the blade member having a blade point at an end edge in the width direction into warp in the width direction, wherein a thickness-deviating process of pressing and flowing material of the blade member to at least one side of a portion which front end edges bite into through an operation of making the front end edges narrowed as they go to the front ends, and equipped on dies, invade and bite into a portion near a blade point of the blade member is carried out at plural positions in the length direction on both faces of the blade member so as to deform the blade member at the thickness-deviating processed portions into warp in the width direction.

According to the present invention, if the thickness-deviating process

is carried out on using dies having the front end edges narrowed linearly as they go to the front ends, material of the blade member flows to both side or a single side of a portion which the edges bite into. If the thickness-deviating process is carried out at plural positions in the length direction on both sides of the blade member, a portion near the blade point in the blade member is elongated in the length direction to be longer than a portion far from the blade point. As a result, the blade member is warped in the width direction so that it is deformed and the blade member is bent in the width direction through that deformation by warp. That is, the blade member is bent into such curved configuration that the blade point is expanded.

In this case, because the flowing amount of the material changes corresponding to the biting amount of the edge at the thickness-deviated portions and the elongation amount of the blade member changes, the bending amount of the blade member can be changed by adjusting the biting amount of the edge appropriately and adjusting the pitch of the thickness-deviating portions appropriately. Thus, the curvature radius of the bent blade member can be adjusted freely. Further, because the adjustments of the biting amount of the edge and the pitch of the thickness-deviating portion can be carried out at high precision using computer program, high precision bending process can be carried out without experienced skill.

Further, because according to this method the thickness-deviating process of pressing and flowing material of the blade member to at least one side of the portion which the edges bite into by making the edges invade and bite into a portion near the blade point of the blade member is carried out, the

same thickness-deviating process can be carried out to an intermediate portion as well as the end portion of the blade member and, as a result, a process of leaving only an effective portion by cutting out the end portion of the blade member is not needed so that the yield rate of the material can be improved. Further because the material is not flowed to both sides by compressing the blade member in the thickness direction with the dies (compression type), the front end edges of the dies are made to invade and bite into the blade material and, thus, there is an advantage that the force for pressing the dies to the blade member can be extremely smaller than the compression type and, accordingly, it is possible to provide a processing device at a cheaper price.

According to the present invention, preferably, the thickness-deviating process is carried out with the linear shape of the front end edges meeting the width direction of the blade member. Consequently, the flow direction of the material of the blade member meet the length direction of the blade member thereby the bending process accuracy being improved.

Further, preferably, in the thickness-deviating process, the biting amount of the front end edges of the dies to the blade member is increased gradually at a portion nearer the blade point of the blade member. Consequently, because according to this method, even a blade member having poor ductility is elongated more at a portion nearer the blade point, the method for bending the blade member can be executed more smoothly.

According to the method of the present invention, it is possible to adopt such a procedure of carrying out the thickness-deviating process on the blade material after a specified portion in the length direction of the belt-like

blade member having a blade point at an end edge in the width direction is bent to a desired shape. Consequently, after the straight belt-like blade member is bent in the thickness direction using an automatic bending machine, the blade point can be deformed into a curved shape.

According to the method of the present invention, it is possible to adopt a method of moving thickness-deviating processed portion successively in one direction of the length direction of the blade member. Consequently, if the means for carrying out the thickness-deviating process on the blade member at a constant position is adopted, the blade member can be fed intermittently to a portion in which the thickness-deviating process is to be executed only by feeding the blade member in the length direction, and thus, the necessity of repeating the operation for feeding the blade member successively or in an opposite direction is eliminated, thereby the bending process efficiency being improved by that amount.

Further, preferably, the dies are disposed on both sides across the blade member such that they are capable of moving relative to each other in the direction of approaching/breaking away and by approaching the dies relative to each other, the thickness-deviating process is carried out to both sides of the blade member at the same time. Consequently, because uniform flow of material is generated on both sides of the blade member, it is possible to bend the blade member in the width direction while suppressing the bending deformation in the thickness direction.

Further, preferably, the target for this method is such a blade member, in which slit-like cutouts long in the width direction are provided at plural positions at an interval in the length direction and the dimension

between a cutout end at a cutout forming position and the end edge in the width direction of the blade member is shorter than the width at a portion in which the cutout is not formed. Consequently, there is such an advantage that even in a blade member having a large width, the portion in which the cutout is formed can be made easy to bend by making the interval between the cutout end at the cutout forming position and the end edge in the width direction of the blade member short.

As described above, according to the present invention, the straight belt-like blade member can be bent partially or its entire length can be bent. Particularly because the thickness-deviating process according to the present invention is pressing and flowing material of the blade member to at least one side of the portion which the edges bite into by making the edges invade and bite into a portion near the blade point of the blade member, the same thickness-deviating process can be carried out to an intermediate portion as well as the end portion of the blade member. Further because the material is not flowed to both sides by compressing the blade member in the thickness direction with the dies (compression type), the front end edges of the dies are made to invade and bite into the blade material and thus, there is an advantage that the force for pressing the dies to the blade member can be extremely smaller than the compression type and accordingly, it is possible to provide a processing device at a cheaper price. This method for bending the blade member will be described further in detail with reference to the next embodiment.

According to another aspect of the present invention, there is provided a device for bending a blade member in the width direction of a

blade member by deforming the blade member having a blade point at an end edge in the width direction to warp in the width direction, comprising: a pair of dies disposed on both sides across a belt-like blade member such that they are capable of moving relative to each other in the direction of approaching/breaking away; and front end edges narrowed linearly as they go to the front ends, disposed on these dies and meeting each other in the width direction. Then, according to the present invention, preferably, the thickness-deviating process of pressing and flowing material of the blade member to at least one side of a portion which the front end edges bite into through a biting operation of making said front end edges invade and bite into a portion near the blade point of the blade member by moving the pair of said dies such that they approach each other.

In this device for bending a blade member, preferably, the front end edges are so inclined that the biting amount of the front end edges to the blade member in the thickness-deviating process increases more gradually at a portion nearer the blade point.

This device for bending can be controlled with a computer and consequently, the blade member can be processed without any experienced skills. The operation of this device for bending the blade member will be described further in detail about the following embodiments.

BRIEF DESCRIPTION OF THE DRAWINGS

Fig. 1 is an appearance drawing showing an embodiment of the device for bending blade member of the present invention.

Fig. 2 is an explanatory diagram of major portions indicating the use

condition of the same device in enlargement.

Fig. 3 is a schematic explanatory diagram of a feeding roller synchronizing mechanism.

Fig. 4 is an explanatory diagram indicating the disposition of a die.

Fig. 5A is a side view for explaining the arrangement of die and the shape of a front end edge thereof.

Fig. 5B is a side view showing the operation in detail.

Fig. 6 is a lateral plan view showing the operation.

Fig. 7 is an explanatory diagram of the shape of the blade and bending process procedure.

Fig. 8 is an explanatory diagram showing the disposition of the rotary type die.

Fig. 9 is a side view thereof.

Fig. 10 is an explanatory diagram of other blade member.

Fig. 11 is an appearance drawing of a blade member before bending.

Fig. 12 is an appearance drawing of a blade member during bending.

Fig. 13 is an appearance drawing of a blade after bending.

Fig. 14 is an explanatory diagram showing use condition of a rotary die with a perspective view.

Fig. 15 is an explanatory diagram showing the side view of the use condition of the rotary die.

Fig. 16 is an explanatory diagram of a belt-like blade member.

Fig. 17 is an explanatory diagram of a conventional bending process.

Fig. 18 is an explanatory diagram of a roller shape.

Fig. 19 is an explanatory diagram of a blade member as a product

produced by a bending process.

BEST MODE FOR CARRYING OUT THE INVENTION

Fig. 1 is an appearance drawing showing the embodiment of the device for bending the blade member of the present invention. Fig. 2 is an explanatory diagram of major portions indicating the use condition of the same device in enlargement. Fig. 3 is a schematic explanatory diagram of a feeding roller synchronizing mechanism. Fig. 4 is an explanatory diagram showing the disposition of the die.

In this device for bending the blade member, a work bench 3 is installed on a casing 2 and a pair of dies 4, 5 are disposed on the work bench 3 such that they oppose each other.

The casing 2 contains a die driving mechanism 6 for approaching/breaking away a pair of dies 4, 5. In the die drive mechanism 6 shown in the same figure, two movable levers 61, 62 on which the pair of dies 4, 5 are mounted each are connected by a lateral shaft 63 at their intermediate portions such that they are capable of swinging relative to each other and nut bodies 64, 65 mounted on the bottom ends of the movable levers 61, 62 are fit to a screw shaft 67 connected to a motor 66 through screw. Here, in the screw shaft 67, a screw portion 67a fit to the one side nut body 64 and a screw portion 67b fit to the other side nut body 65 have opposite screw directions. According to this die drive mechanism 6, by switching the rotation direction of the motor 66 to normal direction and opposite direction alternately, the pair of dies 4, 5 are moved in the approaching direction and the break-away direction alternately with respect to the lateral shaft 63. In

the meantime, inside the casing 2 is provided a grooved roller 79 (the one having the same structure as described in Fig. 17) for supporting the blade point of the blade member 1.

A supporting column 68 is provided on the work bench 3 and an arm 71 is mounted on this supporting column 68 with a spring body 69 such that it is always urged in an upward direction. A supporting/feeding roller 72 for fixing the position, a drive motor 74 for providing this supporting/feeding roller 72 with a rotation and a pressing/feeding roller 73 capable of approaching/leaving the supporting/feeding roller 72 are mounted at the front end portion of the arm 71. A handle 75 for descending an arm 72 against the urging of the spring body 69 is mounted on this arm 72 through a supporting shaft 76. The handle 75 and the pressing/feeding roller 73 are linked through a link mechanism 77 to convert the vertical swing action of the handle 75 to the approaching/leaving action of the pressing/feeding roller 73 with respect to the supporting/feeding roller 72. Further, as shown in Fig. 2, a blade member pressing roller 78 is provided on the side of the arm 71 and a lock mechanism (not shown) for fixing the arm 71 at the descent position is provided.

In this device for bending the blade member, when the arm 71 is descended from the upward position in Fig. 1 against the urging of the spring body 69 by pressing down the handle 75, the blade end of the blade member 1 mounted on the grooved roller 79 is pressed by the blade member pressing roller 78 as shown in Fig. 2 and after that, when the handle 75 is swung downward around the supporting shaft 76, the pressing/feeding roller 73 approaches the supporting/feeding roller 72 as shown in the same figure, so

that the blade member 1 is nipped between both the rollers 72 and 73. At the same time, the arm 71 is locked at its descent position by the above-described lock mechanism. With this state, the bending process is carried out and during that bending process, the supporting/feeding roller 72 is rotated intermittently so that the blade member 1 is fed out in a predetermined direction. When the feeding of the blade member 1 is stopped, the dies 4, 5 on the both sides of the blade member 1 carry out approaching/break-away operation with driving power of the motor 66 used as a driving source. The bending process will be described later.

As shown in Fig. 3, timing gears 72a, 73a are joined coaxially to the supporting/feeding roller 72 and the pressing/feeding roller 73 and the timing gears 72a, 72b are meshed with each other so that the rotations of the supporting/feeding roller 72 and the pressing/feeding roller 73 are synchronized accurately.

Next, as shown in Fig. 4, a pair of the dies 4, 5 disposed such that they oppose each other have a symmetrical shape and the dies 4, 5 have front end edges 41, 51 which are narrowed as they go to their front ends and an opening angle between the front end edges 41 and 51 is specified to be 45 degrees. If explaining further in detail, the front end edges 41, 51 are narrowed as they go to the front ends when viewed in the plan view and the side view shape is expressed linearly as shown in Fig. 2. Therefore, if the die 4 on the left side is pressed against the blade member 1 with a predetermined force and the front end edge 41 of the die 4 bites into the left side face of the blade member 1. When the die 5 on the right side is pressed against the blade member 1 with a predetermined force, the front end edge 51 of the die 5

bites into the right side face of the blade member 1.

Figs. 5A, 5B are side views showing the detail of the disposition of the dies 4, 5 and the configuration and operation of the front end edges 41, 51. Fig. 6 is a lateral plan view showing the operation and Fig. 7 is an explanatory diagram of the configuration of the blade member 1 and the bending process procedure.

As shown in Fig. 5A, the front end edges 41, 51 of the dies 4, 5 opposing each other on both side across the blade member 1 are inclined such that they are expanded as they go upward. As shown in Fig. 7, the blade member 1 is a belt-like member and includes long slit-like cutouts 11 in the width direction at plural positions separated at each equal interval in the length direction. The dimension between a cutout end 13 at the cutout forming position and an end edge in the width direction (that is, blade point 12) in the width direction of the blade member 1 is shorter than the width dimension at a portion in which no cutout is formed.

Next, a method for bending the blade member 1 using the above-described device for bending the blade member will be described.

As shown in Fig. 2, the blade member 1 is nipped by the grooved roller 79 and the blade member pressing roller 78 so that it is not deviated and the supporting/feeding roller 72 is rotated intermittently with the blade member 1 nipped between the supporting/feeding roller 72 and the pressing/feeding roller 73 so that the blade member 1 is fed intermittently and when feeding of the blade member 1 is stopped, a pair of the dies 4, 5 are driven in the direction of approaching/breaking away once or only necessary times. Further, the pair of dies 4, 5 bite into a portion near the blade point 12

of the blade member 1. If an operation for approaching/breaking away the pair of dies 4, 5 is carried out, as shown in Fig. 7, biting traces 14 of the dies 4, 5 are left linearly in the blade member 1 in the same quantity as the time of frequency. In the meantime, an arrow "a" indicates the advancement direction of the biting traces 14.

Because as shown in Fig. 6, the edges 41, 51 invade into the each side face of the blade member 1 at positions where the edges 41, 51 of the dies 4, 5 bite into the blade member 1, thereby carrying out the thickness-deviating process in which material of the blade member 1 is pressed and flows toward both sides of the edges 41, 51 as indicated with arrows F1, F2. Thus, in the blade member 1, the portion near the blade point 12 is elongated in the length direction so that it becomes longer than a portion far from the blade point 12. As a result, the blade member 1 is warped in the width direction and deformed so that the blade point 12 is expanded into a curved shape. Then, the amount of flow material changes corresponding to the biting amount of the edges 41, 51 at such a thickness-deviated portion and the amount of elongation of the blade member 1 changes. Thus, by adjusting the biting amount of the edges 41, 51 appropriately and adjusting the pitch of the thickness-deviated portion appropriately, the amount of bending of the blade member 1 can be changed. Thus, the radius of the curvature of the bent blade member 1 can be adjusted freely. Further, because the biting amount of the edges 41, 51 and the pitch at the thickness-deviated portion can be adjusted at high precision using a computer program, the high precision bending process can be carried out by everybody without any accumulated skill.

Particularly because as described with reference to Fig. 5A, this embodiment adopts such a structure in which the front end edges 41, 51 of the dies 4, 5 opposing each other on both sides across the blade member 1 are inclined such that they are expanded as they go upward, in the thickness-deviating process of pressing the front end edges 41, 51 of the dies 4, 5 into both faces of the blade member 1 as indicated with an arrow P in Fig. 5B, the biting amount of the front end edges 41, 51 of the dies 4, 5 to the blade member 1 increases more gradually at a portion nearer the blade point 12 of the blade member 1 as shown in Fig. 5B. Thus, at the portion which the front end edges 41, 51 bite into, the flowing amount of material changes corresponding to the biting amount and the elongation amount of the blade member 1 changes. Thus, the elongation amount of the blade member 1 increases at a portion nearer the blade point 12 thereby achieving reasonable bending process. In Fig. 5B, the maximum biting amount of the front end edge 41 of the die 4 on one side is expressed with a symbol "d" and inclination angles with respect to the vertical line of the front end edges 41, 51 are expressed with $\theta 1$, $\theta 2$. In the meantime, the blade point 12 is elongated by the substantially same length by induction of the elongation of the portion nearest the blade point 12. Thus, the thickness-deviated portion is deformed into the curved shape in which the blade point 12 of the blade member 1 is expanded.

Because this thickness-deviating process presses and flows material of the blade member 1 toward both sides of the biting portion of the edges 41, 51 through an operation of making the edges 41, 51 invade and bite into a portion near the blade point 12 of the blade member 1, this can be carried out

for an intermediate portion as well as the end portion of the blade member 1. As a result, the process of cutting out the end portion of the blade member 1 to leave only an effective portion is not necessary, so that the yield rate of material can be raised by that amount.

Further, because this thickness-deviating process is a process of making the front end edges 41, 51 of the dies 4, 5 invade and bite into the blade material but not compressing the blade member 1 in the thickness direction with the dies 4, 5, there is such an advantage that a force for pressing the dies 4, 5 to the blade member 1 does not need to be so large.

Because according to this embodiment, the opening angles of the front end edges 41, 51 of the dies 4, 5 are set to 45 degrees, the moving directions of the material of the blade member 1 by the thickness-deviating process is to both directions with respect to the edges 41, 51. However, by devising the plan view shapes of the front end edges 41, 51, it is possible to set the moving directions of the material of the blade member 1 by the thickness-deviating process to only one direction of the front end edges 41, 51. For example, it is possible to set the one side of the front end edges 41, 51 perpendicular to the blade member 1 while setting the other surface to an inclined face to the one side so as to make the moving direction of the material of the blade member 1 by the thickness-deviating process to only the one side direction of the front end edges 41, 51.

Further, because according to this embodiment, the dies 4, 5 having the front end edges 41, 51 are disposed on both sides across the blade member 1 and the thickness-deviating process is carried out by approaching and breaking away those dies 4, 5, the dies 4, 5 can be formed into a rotary type as

shown in Fig. 8 or 9 from this viewpoint. That is, Fig. 8 is an explanatory diagram showing the disposition of the rotary type dies 4, 5 and Fig. 9 is a side view thereof.

As shown in Fig. 8, the rotary type dies 4, 5 have a plurality of front end edges 41, 51 having linearly narrowed tip, which are disposed circularly along the outer periphery at every equal angle. If the front end edges 41, 51 are made to successively invade and bite into a portion of the blade member 1 near the blade point 12 as the rotary type dies 4, 5 are rotated synchronously, the biting traces 14 as described in Fig. 7 are formed continuously in the blade member 1 without stopping the blade member 1. As a result, the continuous thickness-deviating process is carried out so that the material of the blade member 1 flows to at least the one side of the portion which the front end edges 41, 51 bite by the thickness-deviating process and the blade member 1 is deformed into a warp in the width direction and the blade point 12 is expanded. In the meantime, it is preferable that the plurality of the front end edges 41, 51 equipped on the outer periphery of the rotary type dies 4, 5 disposed on both sides of the blade member 1 such that they oppose each other are inclined so that they are expanded as they go upward like the case described in Fig. 5.

If when the rotary type dies 4, 5 are used, as shown in Fig. 9, the bottom ends of the rotary shafts 42, 52 of the dies 4, 5 are supported by bearings portions 43, 53 and these bearing portions 43, 53 are linked with an operating mechanism having the function for approaching or breaking away, a behavior that the dies 4, 5 escape from the blade member 1 during the thickness-deviating process never occurs if the bearing portions 43, 53 are

urged in the approaching direction by that operating mechanism so as to achieve effective thickness-deviating process.

Fig. 10 shows a modification of the blade member 1 which is a bending process object. In this blade member 1, the blade point 12 is formed into waves. This blade member 1 is adopted when a soft type is used as the anvil 200 described in Fig. 14 and the blade point 12 is equipped with a biting function to a workpiece.

Figs. 11 to 13 show the bending process procedure for obtaining the blade member 1 mounted o n the rotary die 100 explained in Fig. 14. Fig. 11 shows the blade member 1 which is bent into a substantially rectangular shape in plan view using an automatic blade member bending machine and the bending process method of the present invention can be applied to the blade member 1. In the blade member 1 before the bending process method of the present invention is applied, as evident from Fig. 11, the entire blade point 12 is positioned on a virtual horizontal plane. Fig. 12 shows a state in which one side of the rectangular blade member 1 is thickness-deviated from its end portion to the intermediate portion. As evident from the same figure, the thickness-deviated portion is changed to a curved shape in which the side view shape of the blade point 1 is expanded. Fig. 13 shows the blade member 1 which is obtained by carrying out this kind of the bending work on the one side of the rectangular blade member 1 and its opposing side.

According to the blade member bending process method of the present invention, the thickness-deviating process can be carried out for a specified range or the entire portion of the blade member 1 successively from the end portion or started from the specified range or the intermediate

portion of the entire length portion of the blade member 1.

INDUSTRIAL APPLICABILITY

The blade member bending method and blade bending device of the present invention can be applied to manufacture a blade member for forming notch or perforation in a workpiece such as sheet paper by using a rotary die.